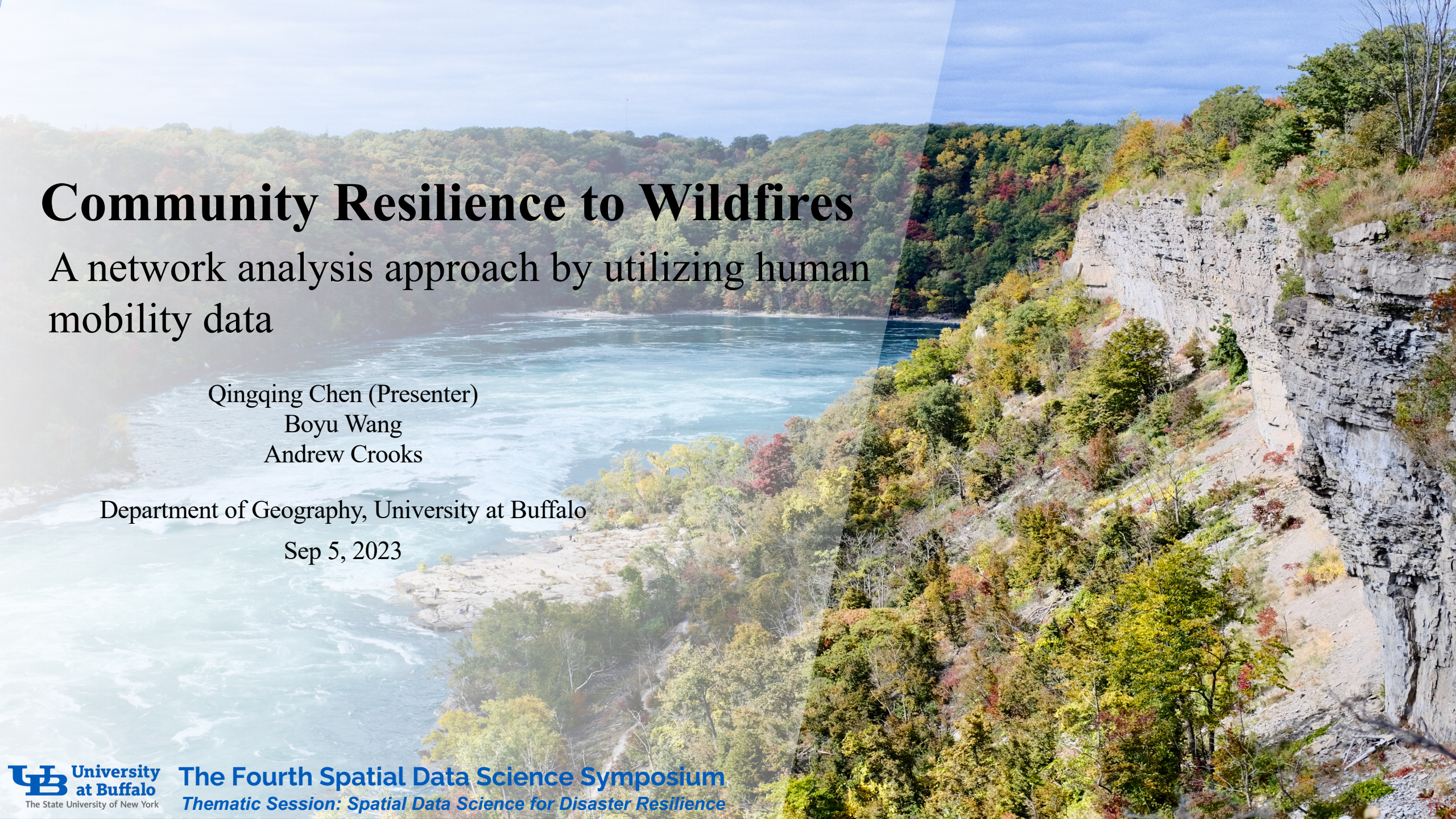

Community Resilience to Wildfires

A network analysis approach by utilizing human mobility data

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Sep 5, 2023

University at Buffalo
The State University of New York

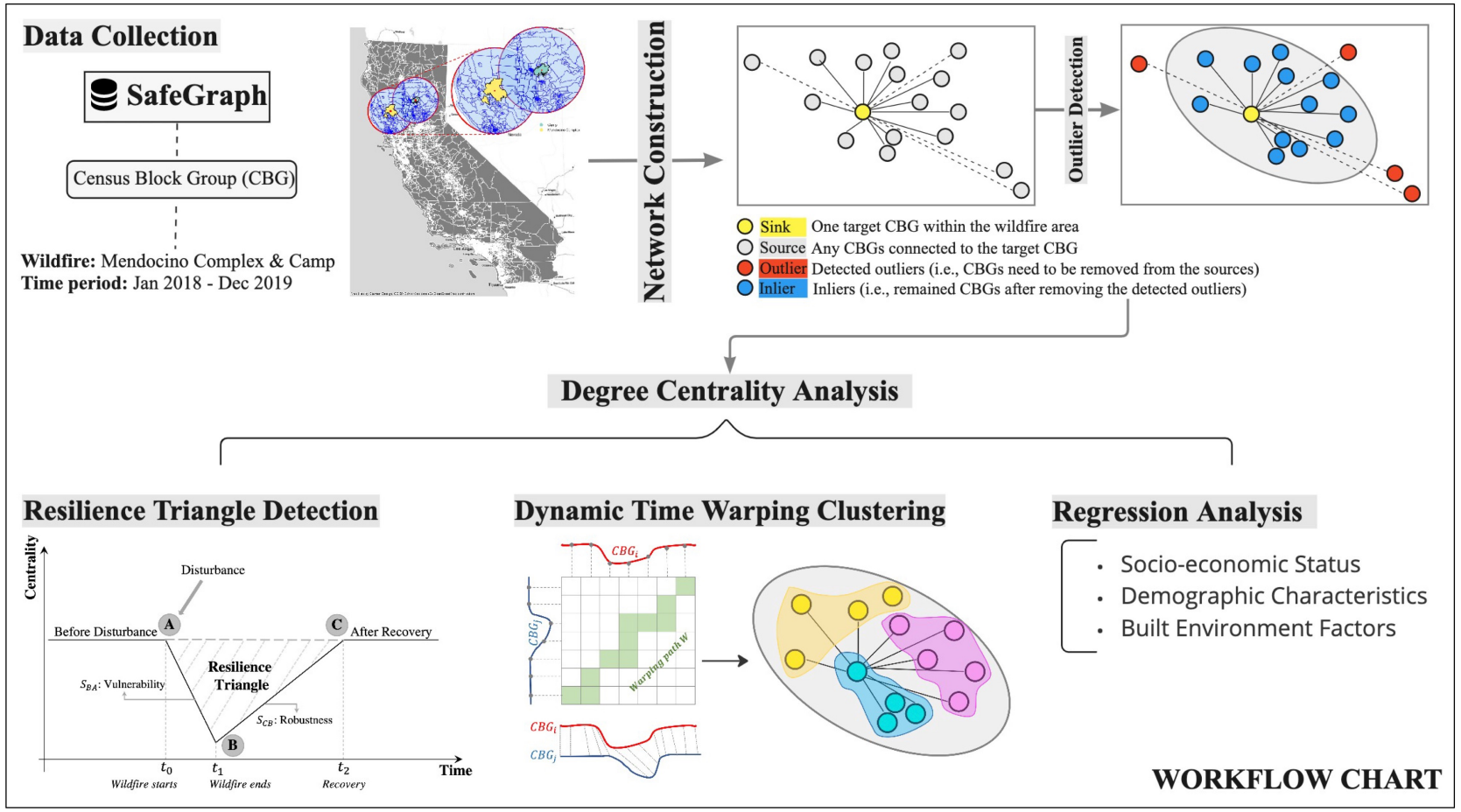
The Fourth Spatial Data Science Symposium
Thematic Session: Spatial Data Science for Disaster Resilience

Disasters (e.g., wildfires) often results in significant effects on the environment, wildlife and human population.

Resilience

How well a system can re-establish stability and functions from the disruption of a disaster over time (National Academies, 2012).

A framework to capture potential impacts of *dynamic* disruptions of a disaster, especially on collective human behaviors to assess a community's resilience to wildfires in space and time.



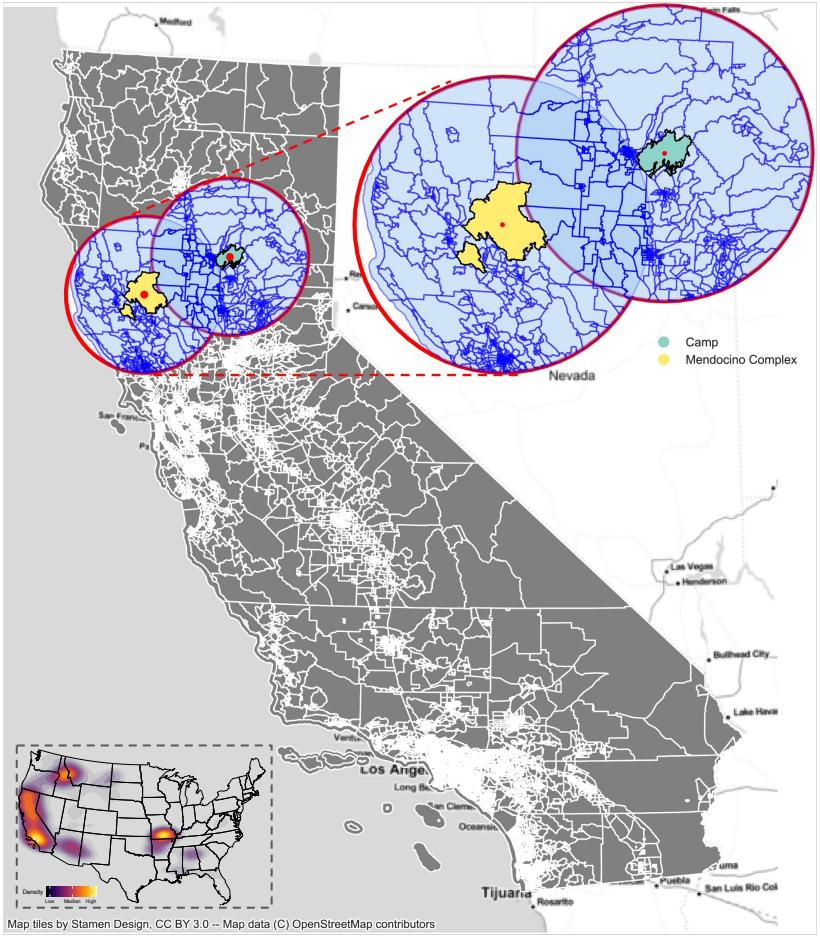
1) Which community is more resilience compared to others and why?
2) Did a community bounce back to its original status after a certain time or form a new normalcy?
3) What are the similarities and differences among communities?

Scale up the concept of resilience to a more empirical framework that can be quantified and visualized.

National Academies, 2012. Disaster resilience: A national imperative. National Academies Press, Washington, D.C.

SafeGraph: Jan 2018 – Dec 2-19
- Census Brock Group (CBG), monthly interval

Wildfire Name	Start Date	End Date	Description
Mendocino Complex	08/27/2018	01/04/2019	The largest wildfire to date with records back to 1933, which has burned over 450k acres.
Camp	11/8/2018	11/25/2018	The costliest and deadliest wildfire, which has destroyed more than 18,500 buildings.



A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities

Michel Bruneau,[a] M.EERI, Stephanie E. Chang,[b] M.EERI, Ronald T. Eguchi,[c] M.EERI, George C. Lee,[a] M.EERI, Thomas D. O'Rourke,[d] M.EERI, Andrei M. Reinhorn,[e] M.EERI, Masanobu Shinozuka,[f] Kathleen Tierney,[g] M.EERI, William A. Wallace,[h] and Detlof von Winterfeldt[i]
The co-authors of this paper are listed in alphabetical order.

This paper presents a conceptual framework to define seismic resilience of communities and quantitative measures of resilience that can be useful for a coordinated research effort focusing on enhancing this resilience. This framework relies on the complementary measures of resilience: "Reduced failure probabilities," "Reduced consequences from failures," and "Reduced time to recovery." The framework also includes quantitative measures of the "ends" of robustness and rapidity, and the "means" of resourcefulness and redundancy, and integrates those measures into the four dimensions of community resilience—technical, organizational, social, and economic—all of which can be used to quantify measures of resilience for various types of physical and organizational systems. Systems diagrams then establish the tasks required to achieve these objectives. This framework can be useful in future research to determine the resiliency of different units of analysis and systems, and to develop resiliency targets and detailed analytical procedures to generate these values. [DOI: 10.1193/1.1623497]

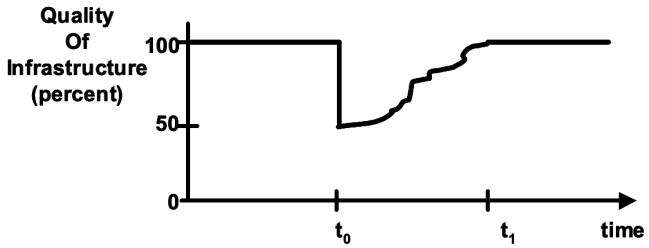
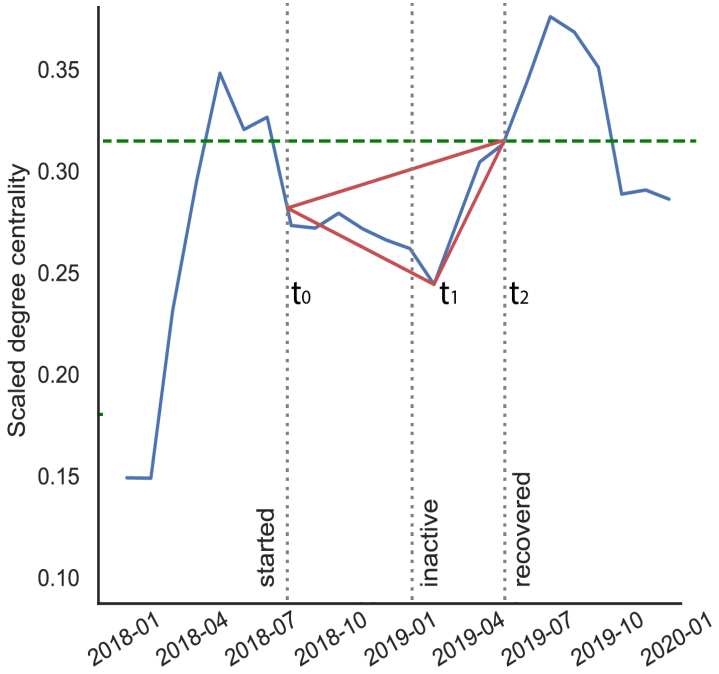
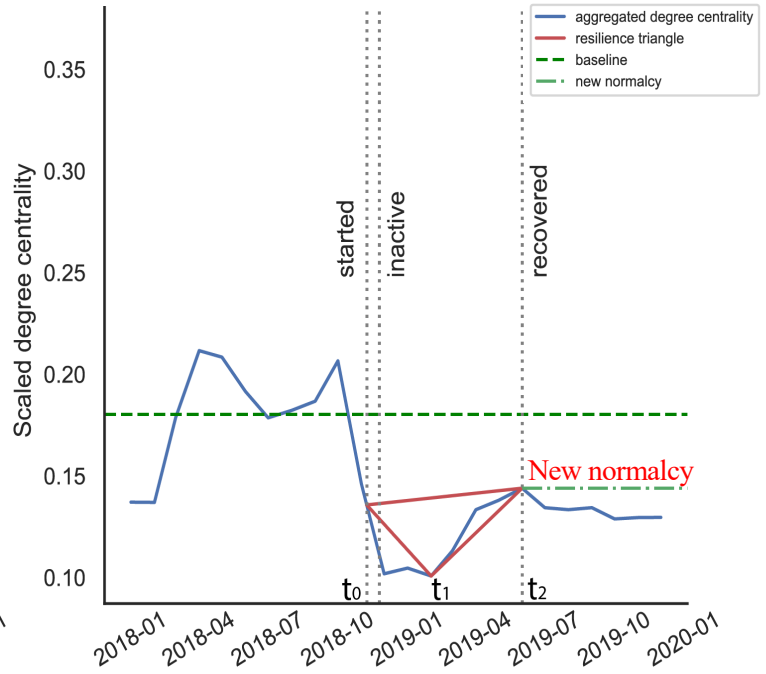


Figure 1. Schematic representation of seismic resilience concept (Bruneau et al. 2003)

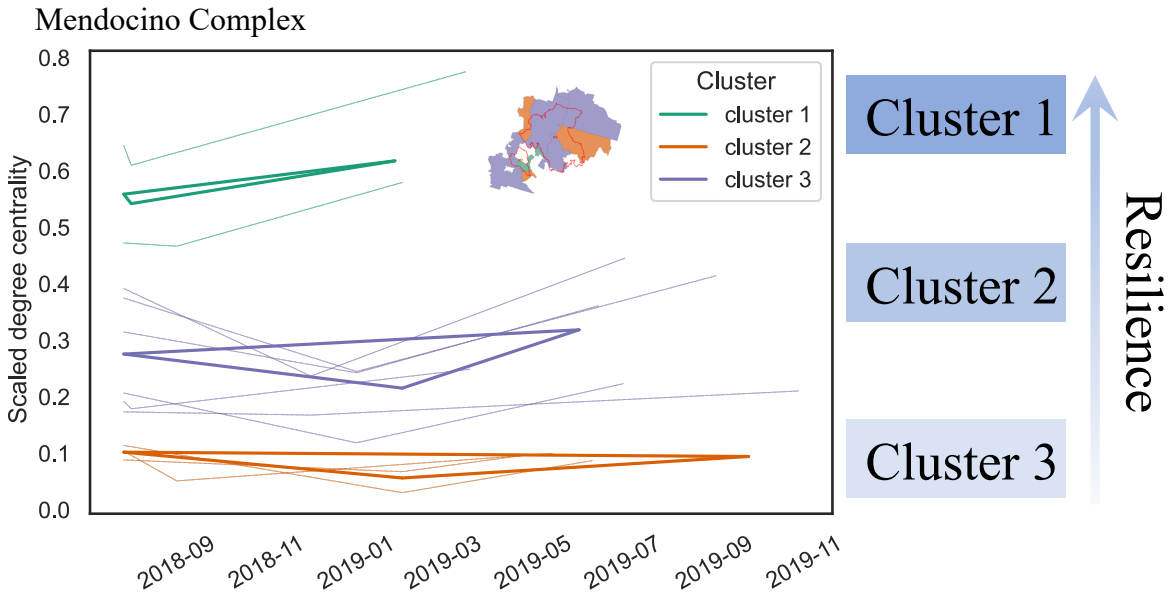
Bruneau, M., Chang, S.E., Eguchi, R.T., Lee, G.C., O'Rourke, T.D., Reinhorn, A.M., Shinozuka, M., Tierney, K., Wallace, W.A., von Winterfeldt, D., 2003. A framework to quantitatively assess and enhance the seismic resilience of communities. Earthquake Spectra 19, 733–752. doi:10.1193/1.1623497. publisher: SAGE Publications Ltd STM.

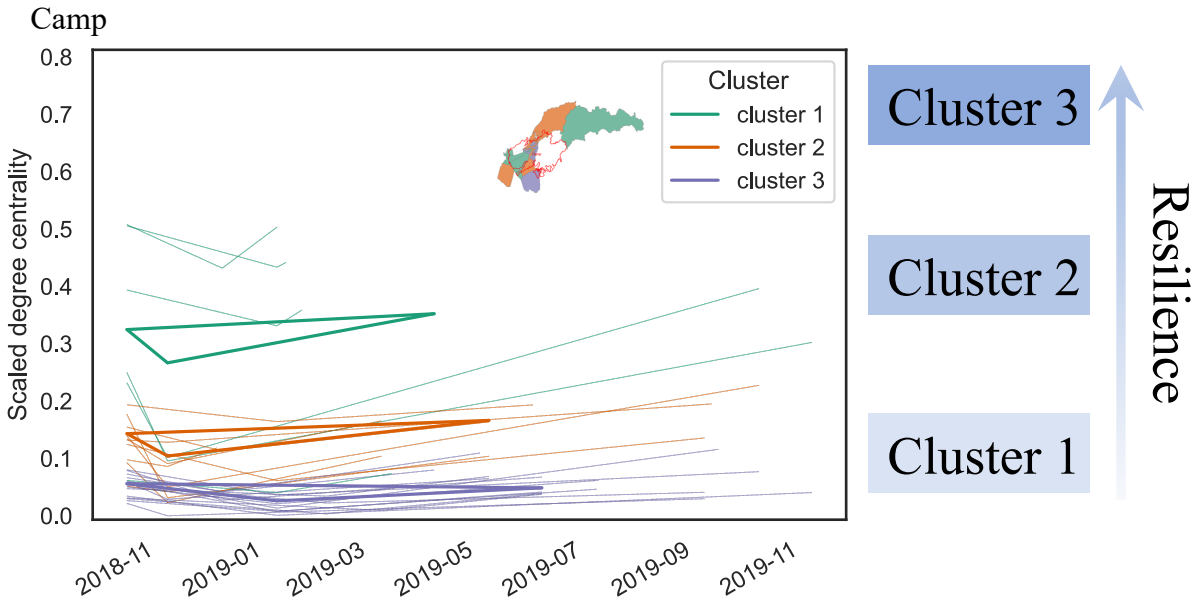




The resilience triangle records the *abrupt losses* in performance of a social unit (i.e., CBG) under the disruption of a disaster.

- **Depth**: the severity of the disruption
- **Length**: the recovery time
- **Area**: the resilience of the social unit.





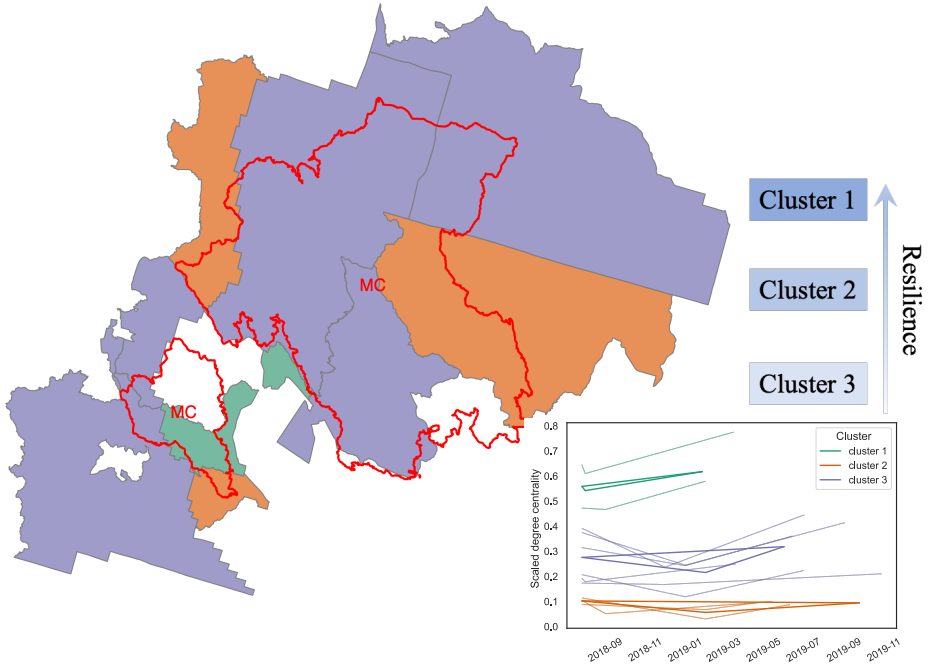
Demographic information

Socio-economic status

Built environment characteristics

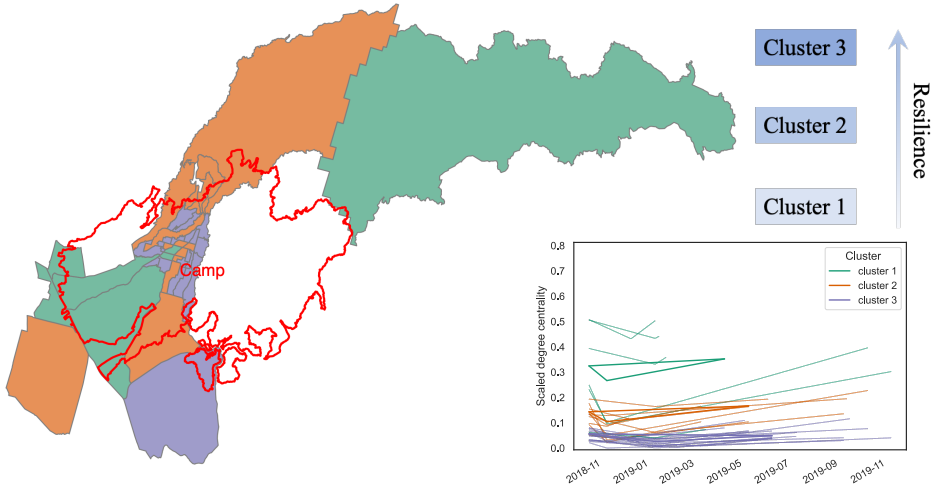
Table 1: Description of independent variables

Independent Variable	Description
AvgDistance	Average distance from home CBGs to a target CBG
%PopDist<3km	Percentage of population travel within 3 km from home CBGs to a target CBG
AreaInWildfire	The area of a target CBG within the wildfire area
# of Housing Units	Number of housing units of a target CBG
Med Household Income	Median household income of a target CBG
MedAgeMale	Median age of male of a target CBG
MedAgeFemale	Median age of female of a target CBG
# of workers	The number of full-time workers in a target CBG
% Pop >Under-graduate	The percentage of people that are undergraduate or higher of a target CBG



Mendocino Complex

- Cluster 1 (most resilient): smallest % of population stay within 3km; smallest area within the wildfire; people are relatively younger
- Cluster 2: the smallest # of housing units; the smallest # of full-time workers, highest median household income; people are relatively elder
- Cluster 3 (least resilient): largest area within the wildfire; largest % of population stay within 3km; high # of housing units; people are relatively elder

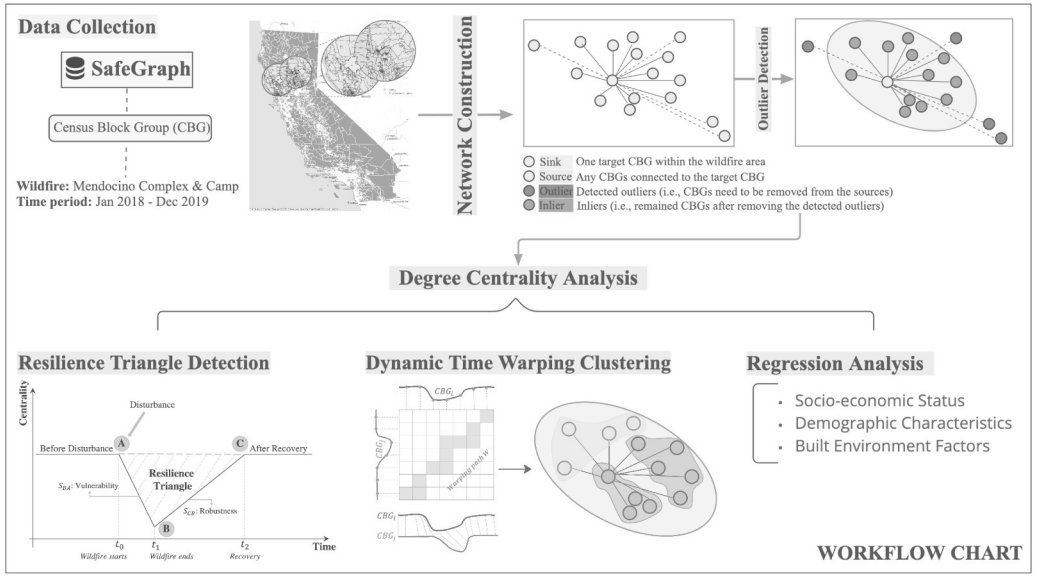


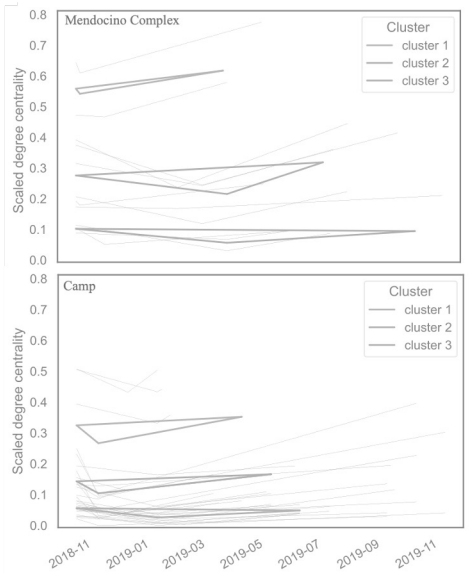
Camp

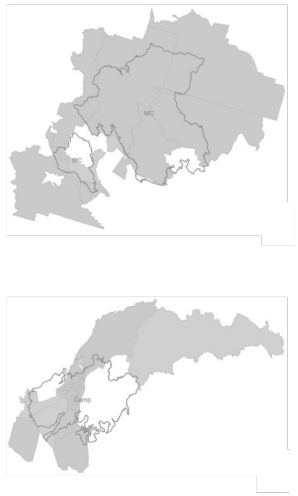
- Cluster 3 (most resilient): smallest area within the wildfire; smallest # of housing units & full-time workers; relatively high median household income;
- Cluster 2: relatively small area within the wildfire; relatively small # of housing units & full-time workers;
- Cluster 1 (least resilient): largest area within the wildfire; largest # of housing units & full-time workers; highest median household income; people are relatively younger

In summary:

- Quantifying community resilience is an open research challenge
- Develops a novel framework to quantify resilience after a disaster based on network analysis and human mobility data combined with the concept of resilience triangle
- Results show community resilience is highly related to socio-economic & built environmental characteristics of the affected areas
- The study paves a way to study disasters & their long-term impacts on society







Cluster 1
Cluster 2
Cluster 3
Resilience
Cluster 3
Cluster 2
Cluster 1
Resilience

THANK YOU FOR YOUR ATTENTION

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